
Standard Method of Test for

Bulk Specific Gravity of Compacted Hot Mix Asphalt Using Saturated Surface-Dry Specimens

AASHTO Designation: T 166-05



**American Association of State Highway and Transportation Officials
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1. SCOPE

- 1.1. This method of test covers the determination of bulk specific gravity of specimens of compacted hot mix asphalt.
- 1.2. *Definition:*
- 1.3. *Bulk specific gravity (of solids)*—the ratio of the weight in air of a unit volume of a permeable material (including both permeable and impermeable voids normal to the material) at a stated temperature to the weight in air of equal density of an equal volume of gas-free distilled water at a stated temperature. The form of the expression shall be:
- $$\text{Bulk specific gravity } x/y \text{ }^{\circ}\text{C} \quad (1)$$
- where:
- x = temperature of the material, and
- y = temperature of the water
- 1.4. This method should not be used with samples that contain open or interconnecting voids and/or absorb more than 2.0 percent of water by volume, as determined in Sections 6.2 or 9.2 herein.
- 1.5. The bulk specific gravity of the compacted hot mix asphalt may be used in calculating the unit mass of the mixture.
- 1.6. The values stated in SI units are to be regarded as the standard.

2. REFERENCED DOCUMENTS

- 2.1. *AASHTO Standards:*
- M 231, Weighing Devices Used in the Testing of Materials
 - T 275, Bulk Specific Gravity of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens

3. TEST SPECIMENS

- 3.1. Test specimens may be either laboratory-molded asphalt mixtures or from HMA pavements. The mixtures may be surface or wearing course, binder or leveling course, or hot-mix base.
- 3.2. *Size of Specimens*—It is recommended that: (1) the diameter of cylindrically molded or cored specimens, or the length of the sides of sawed specimens, be at least equal to four times the maximum size of the aggregate; and (2) the thickness of specimens be at least one-and-one-half times the maximum size of the aggregate.
- 3.3. Specimens shall be taken from pavements with a core drill, diamond or carborundum saw, or by other suitable means.
- 3.4. Care shall be taken to avoid distortion, bending, or cracking of specimens during and after the removal from the pavement or mold. Specimens shall be stored in a safe, cool place.
- 3.5. Specimens shall be free from foreign materials such as seal coat, tack coat, foundation material, soil, paper, or foil.
- 3.6. If desired, specimens may be separated from other pavement layers by sawing or other suitable means. Care should be exercised to ensure sawing does not damage the specimens.

METHOD A

4. APPARATUS

- 4.1. *Weighing Device*—The weighing device shall have sufficient capacity, be readable to 0.1 percent of the sample mass, or better, and conform to the requirements of M 231. The weighing device shall be equipped with a suitable suspension apparatus and holder to permit weighing the specimen while suspended from the center of scale pan of the weighing device.
- 4.2. *Suspension Apparatus*—The wire suspending the container shall be the smallest practical size to minimize any possible effects of a variable immersed length. The suspension apparatus shall be constructed to enable the container to be immersed to a depth sufficient to cover it and the test sample during weighing. Care should be exercised to ensure no trapped air bubbles exist under the specimen.
- 4.3. *Water Bath*—for immersing the specimen in water while suspended under the weighing device, equipped with an overflow outlet for maintaining a constant water level.

5. PROCEDURE

- 5.1. Dry the specimen to a constant mass (Note 1). Cool the specimen to room temperature at $25 \pm 5^{\circ}\text{C}$ ($77 \pm 9^{\circ}\text{F}$), and record the dry mass as *A*. Immerse each specimen in water at $25 \pm 1^{\circ}\text{C}$ ($77 \pm 1.8^{\circ}\text{F}$) for 4 ± 1 minute and record the immersed mass as *C*. Remove the specimen from the water, damp-dry the specimen by blotting with a damp towel as quickly as possible (not to exceed 5 seconds), and determine the surface-dry mass as *B*. Any water that seeps from the specimen during the weighing operation is considered part of the saturated specimen (Note 1). Each specimen shall be immersed and weighed individually.

Note 1—Constant mass shall be defined as the mass at which further drying at $52 \pm 3^{\circ}\text{C}$ ($125 \pm 5^{\circ}\text{F}$) does not alter the mass by more than 0.05 percent. Samples saturated with water shall initially be dried overnight at $52 \pm 3^{\circ}\text{C}$ ($125 \pm 5^{\circ}\text{F}$) and then weighed at two-hour drying intervals. Recently molded laboratory samples, which have not been exposed to moisture, do not require drying.

Note 2—If desired, the sequence of testing operations may be changed to expedite the test results. For example, first the immersed mass *C* can be taken, then the surface-dry mass *B*, and finally the dry mass *A*.

Note 3—Terry cloth has been found to work well for an absorbent cloth. Damp is considered to be when no water can be wrung from the towel.

6. CALCULATION

- 6.1. Calculate the bulk specific gravity of the specimen as follows (round and report the value to the nearest three decimal places):

$$\text{Bulk Specific Gravity} = \frac{A}{B - C} \quad (2)$$

where:

A = mass in grams of the specimen in air,

B = mass in grams of the surface-dry specimen in air, and

C = mass in grams of the specimen in water.

- 6.2. Calculate the percent of water absorbed by the specimen (on a volume basis) as follows:

$$\text{Percent of Water Absorbed by Volume} = \frac{B - A}{B - C} \times 100 \quad (3)$$

- 6.3. If the percent of water absorbed by the specimen as calculated in Section 6.2 exceeds 2.0 percent, use T 275 to determine the bulk specific gravity.

METHOD B

7. APPARATUS

- 7.1. *Weighing device*—the weighing device shall have sufficient capacity, be readable to 0.1 percent of the sample mass or better, and conform to the requirements of M 231.
- 7.2. *Water Bath*—thermostatically controlled so as to maintain the bath at $25 \pm 0.5^{\circ}\text{C}$ ($77 \pm 0.9^{\circ}\text{F}$).
- 7.3. *Thermometer*—ASTM 17 C (17 F), having a range of 19 to 27°C (66 to 80°F), graduated in 0.1°C (0.2°F) subdivisions.
- 7.4. *Volumeter*¹—calibrated to 1200 mL, or an appropriate capacity depending upon the size of the test sample. The volumeter shall have a tapered lid with a capillary bore.

8. PROCEDURE

8.1. Dry the specimen to a constant mass (See Note 1.). Cool the specimen to room temperature at $25 \pm 5^{\circ}\text{C}$ ($77 \pm 9^{\circ}\text{F}$) and record the dry mass as *A*. Immerse the specimen in the water bath, and let it saturate for at least 10 minutes. At the end of the 10-minute period, fill a calibrated volumeter with distilled water at $25 \pm 1^{\circ}\text{C}$ ($77 \pm 1.8^{\circ}\text{F}$). Remove the saturated specimen from the water bath, damp-dry the specimen by blotting with a damp towel as quickly as possible. Weigh the specimen and record the surface-dry mass as *B*. Any water that seeps from the specimen during the weighing operation is considered part of the saturated specimen.

8.2. Place the specimen into the volumeter, and let it stand for at least 60 seconds. Bring the temperature of the water to $25 \pm 1^{\circ}\text{C}$ ($77 \pm 1.8^{\circ}\text{F}$), and cover the volumeter, making certain that some water escapes through the capillary bore of the tapered lid. Wipe the volumeter dry with a dry absorbent cloth, and weigh the volumeter and its contents (Note 4). Record this weight as *E*.

Note 4—If desired, the sequence of testing operations can be changed to expedite the test results. For example, first the mass of the saturated, damp-dry specimen *B* can be taken. Then the volumeter containing the saturated specimen and water *E* can be weighed. The dry mass of the specimen *A* can be determined last.

Note 5—Method B is not acceptable for specimens that have more than six-percent air voids.

9. CALCULATIONS

9.1. Calculate the bulk specific gravity of the specimen as follows (round and report the value to the nearest three decimal places):

$$\text{Bulk Specific Gravity} = \frac{A}{B + D - E} \quad (4)$$

where:

A = mass in grams of the dry specimen,

B = mass in grams of the surface-dry specimen,

D = mass in grams of the volumeter filled with water at $25 \pm 1^{\circ}\text{C}$ ($77 \pm 1.8^{\circ}\text{F}$), and

E = mass in grams of the volumeter filled with the specimen and water at $25 \pm 1^{\circ}\text{C}$ ($77 \pm 1.8^{\circ}\text{F}$).

9.2. Calculate the percent of water absorbed by the specimen (on a volume basis) as follows:

$$\text{Percent of Water Absorbed by Volume} = \frac{B - A}{B + D - E} \times 100 \quad (5)$$

9.3. If the percent of water absorbed by the specimen as calculated in Section 9.2 exceeds 2.0 percent, use T 275 to determine the bulk specific gravity.

METHOD C (RAPID TEST)

10. PROCEDURE

10.1. This procedure can be used for testing specimens, which are not required to be saved and which contain a substantial amount of moisture. Specimens obtained by coring or sawing can be tested the same day by this method.

- 10.2. The testing procedure shall be the same as given in Sections 5 and 8 except for the sequence of operations. The dry mass *A* of the specimen is determined last as follows.
- 10.3. Place the specimen in a large, flat-bottom drying pan of known mass. Place the pan and specimen in a $110 \pm 5^{\circ}\text{C}$ ($230 \pm 9^{\circ}\text{F}$) oven. Leave the specimen in the oven until it can be easily separated to the point where the particles of the fine aggregate-asphalt portion are not larger than 6.4 mm ($\frac{1}{4}$ in.). Place the separated specimen in the 110°C (230°F) oven, and dry to a constant mass. Constant mass shall be defined as the weight at which further drying at $110 \pm 5^{\circ}\text{C}$ ($230 \pm 9^{\circ}\text{F}$) does not alter the mass by more than 0.05 percent when weighed at 2-hour intervals.
- 10.4. Cool the pan and specimen to room temperature at $25 \pm 5^{\circ}\text{C}$ ($77 \pm 9^{\circ}\text{F}$). Determine the mass of the pan and specimen, subtract the mass of the pan and record the dry mass *A*.

11. CALCULATIONS

- 11.1. Calculate the bulk specific gravity in Sections 6.1 and 9.1.

12. REPORT

- 12.1. The report shall include the following:
- 12.1.1. The method used (*A*, *B*, or *C*).
- 12.1.2. Bulk Specific Gravity reported to the nearest thousandth.
- 12.1.3. Absorption reported to the nearest hundredth.

13. PRECISION

- 13.1. Duplicate specific gravity results by the same operator should not be considered suspect unless they differ more than 0.02.

¹ Suitable aluminum volumeters of different sizes are available from Pine Instrument Co., 101 Industrial Drive, Grove City, PA 16127; and Rainhart Co., 604 Williams St., Austin, TX 78765.